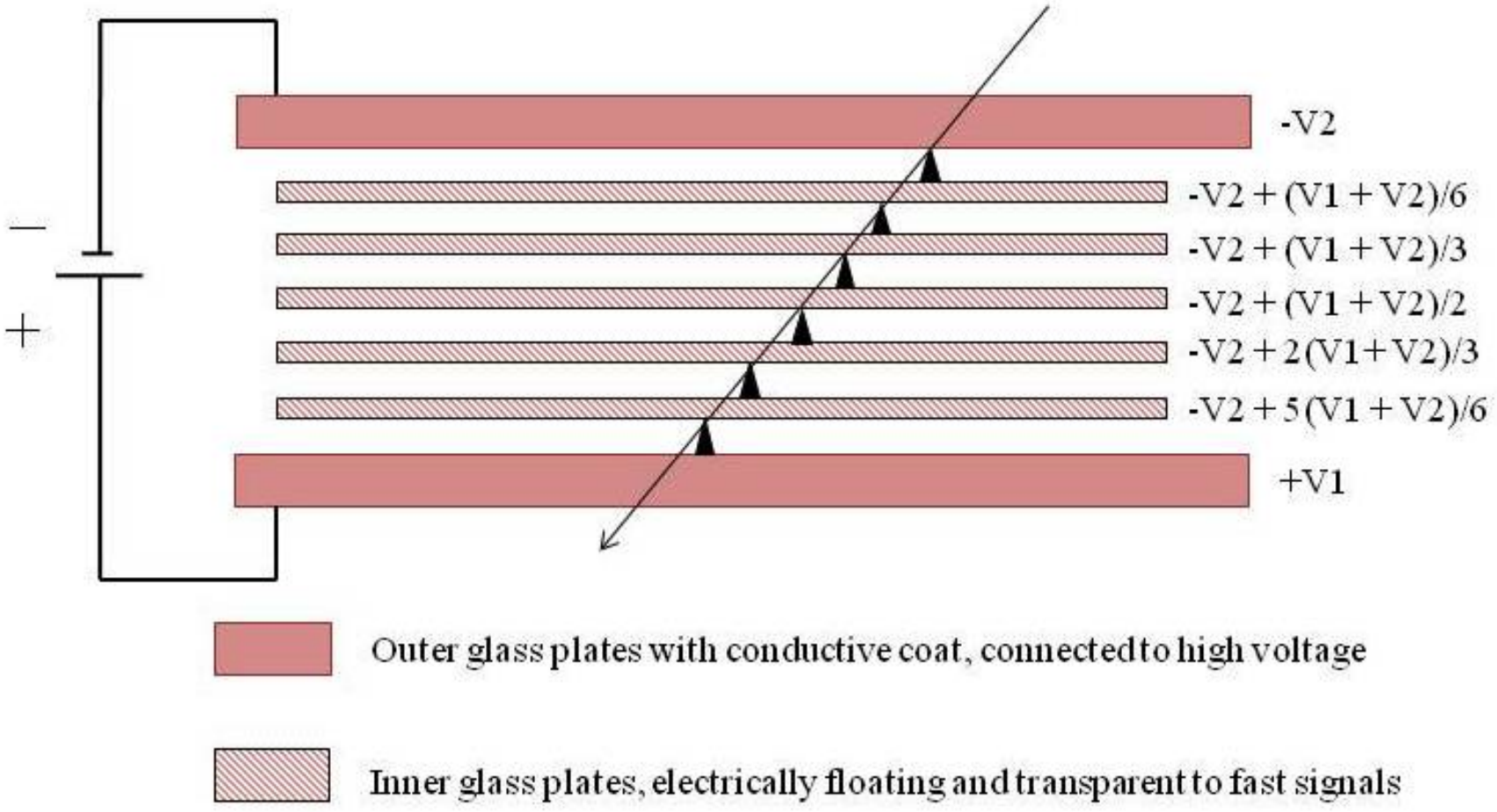
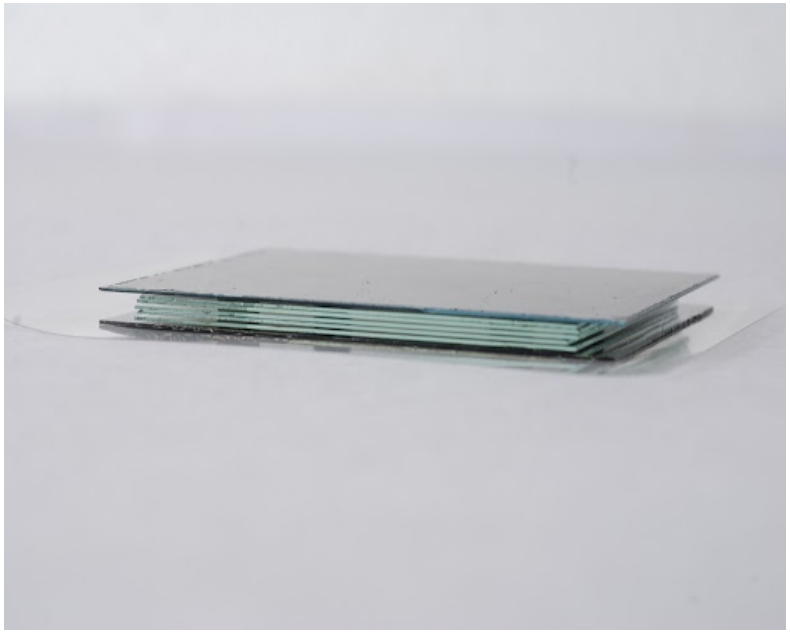
- Design of Six-gap MRPC and its optimization

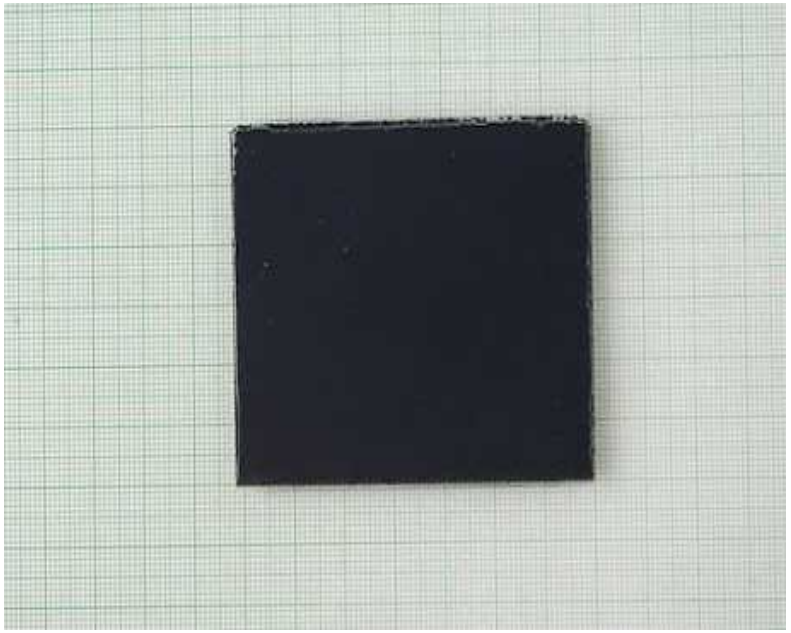
Proposed structure with six sub-gaps

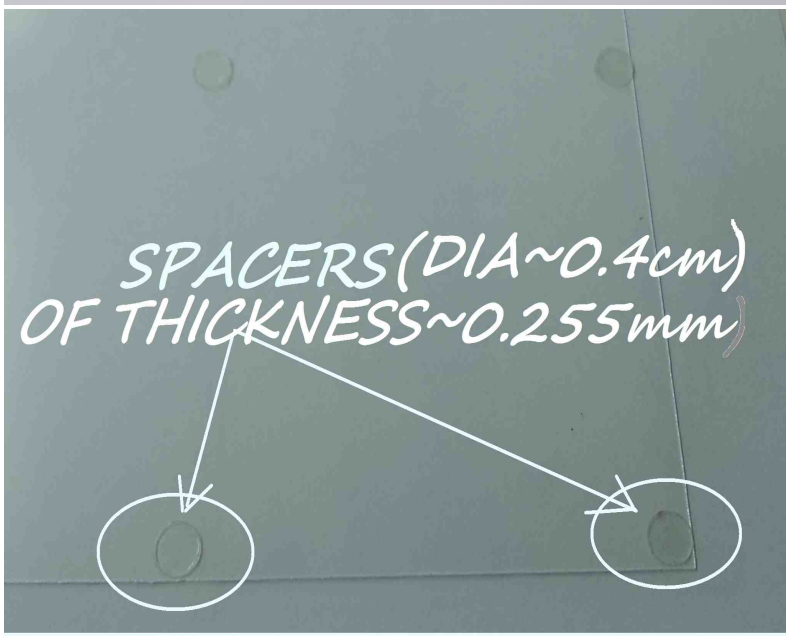


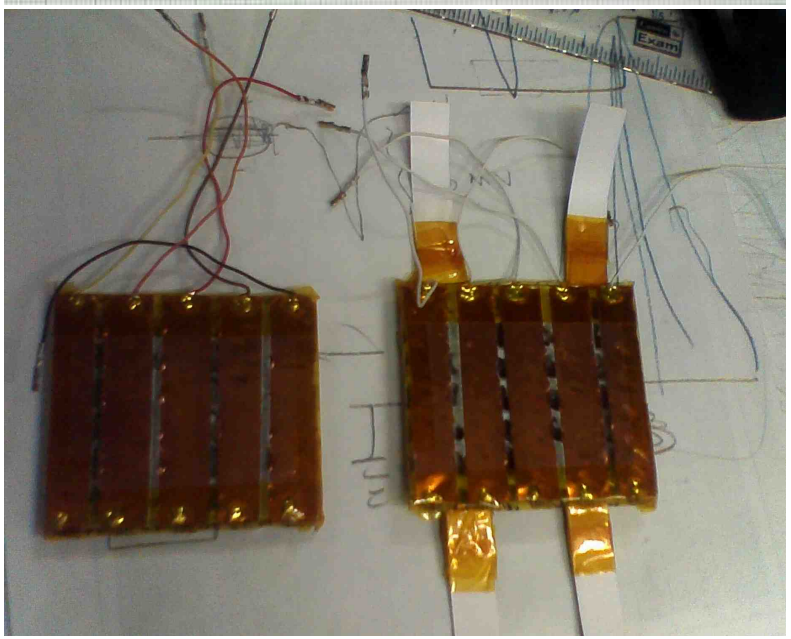
The first design

- We started with small dimension –
  The two outer electrodes $\rightarrow$ 7.5 cm $\times$ 6.5 cm
  The intermediate electrodes $\rightarrow$ 7 cm $\times$ 6 cm
  Thickness $\sim$ 400 μm
- The detector was confined in a sealed enclosure through which the gas mixture was passed.

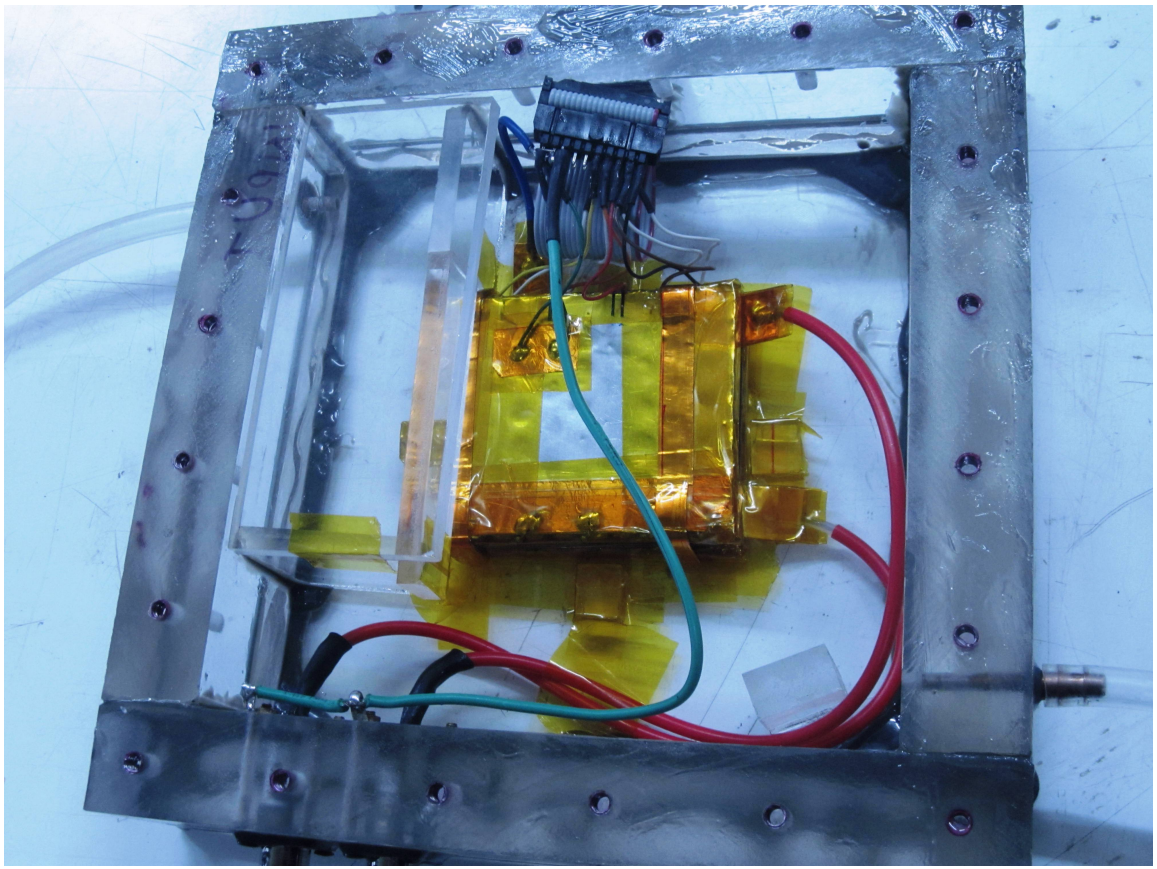





SPACERS(DIA~0.4cm)
OF THICKNESS~0.255mm

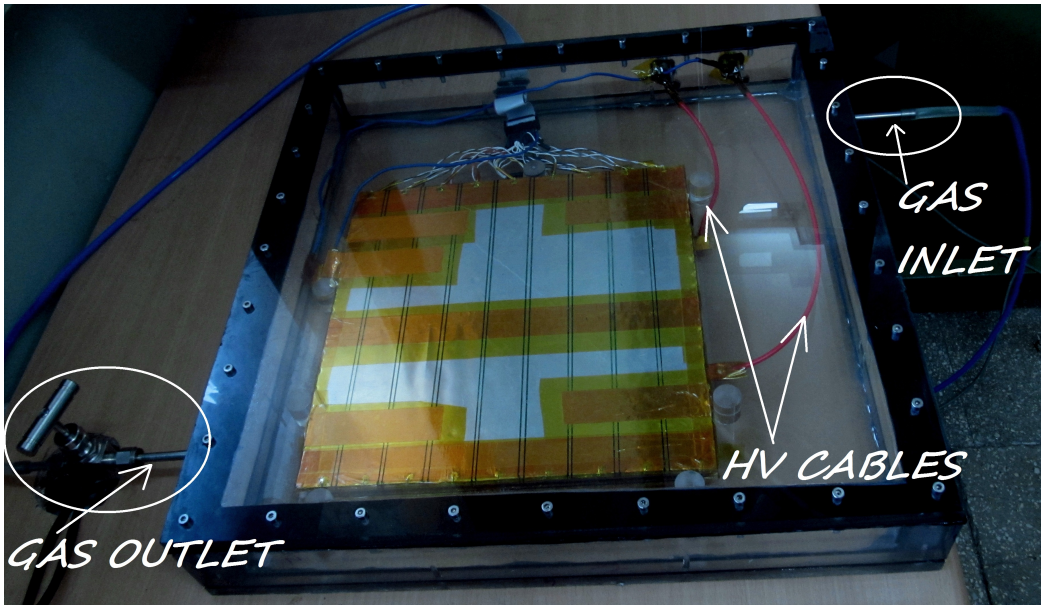


The first design



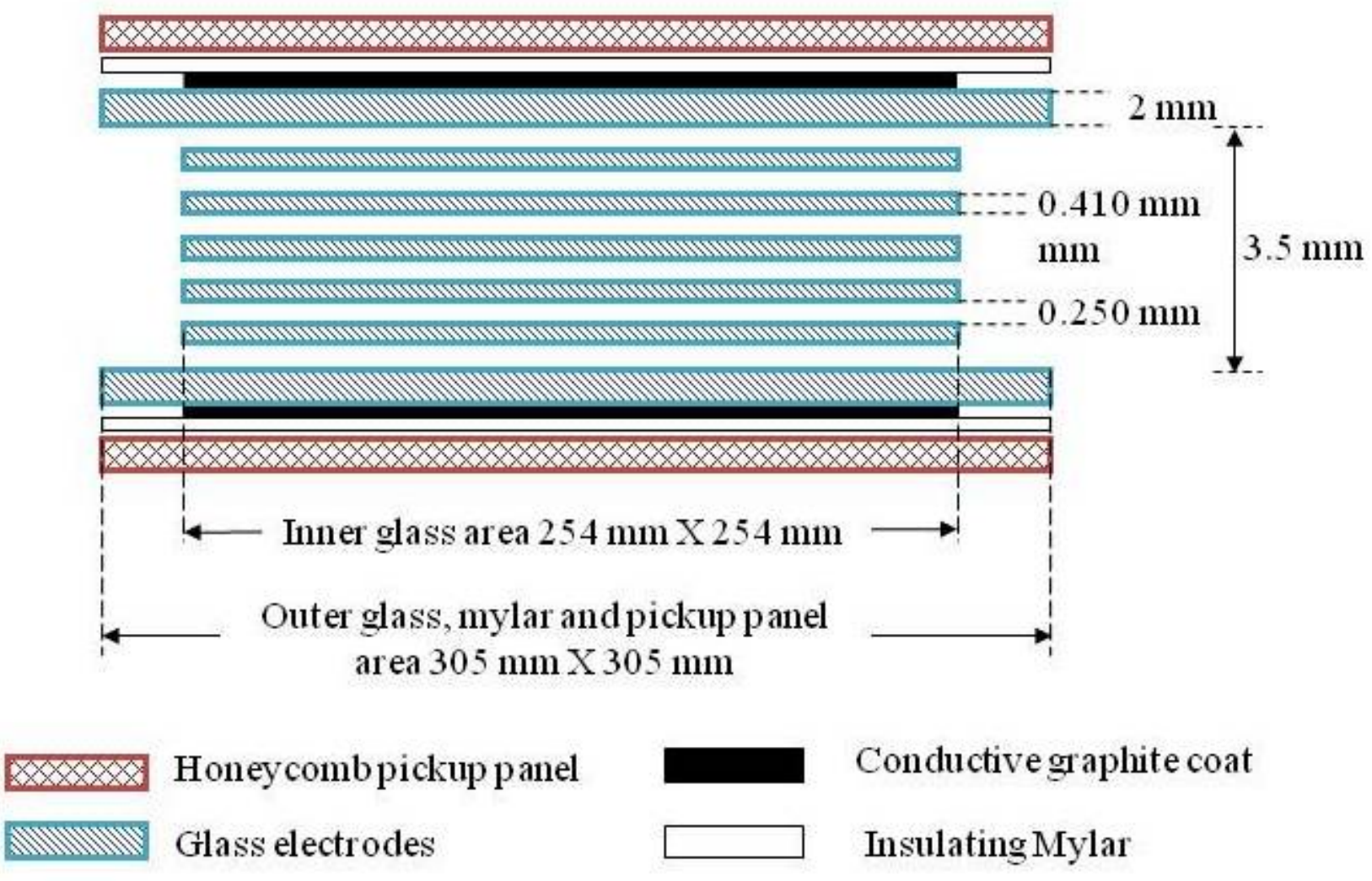
- **3 events were recorded!**
- Frequent sparking damaged the detector.

Next one



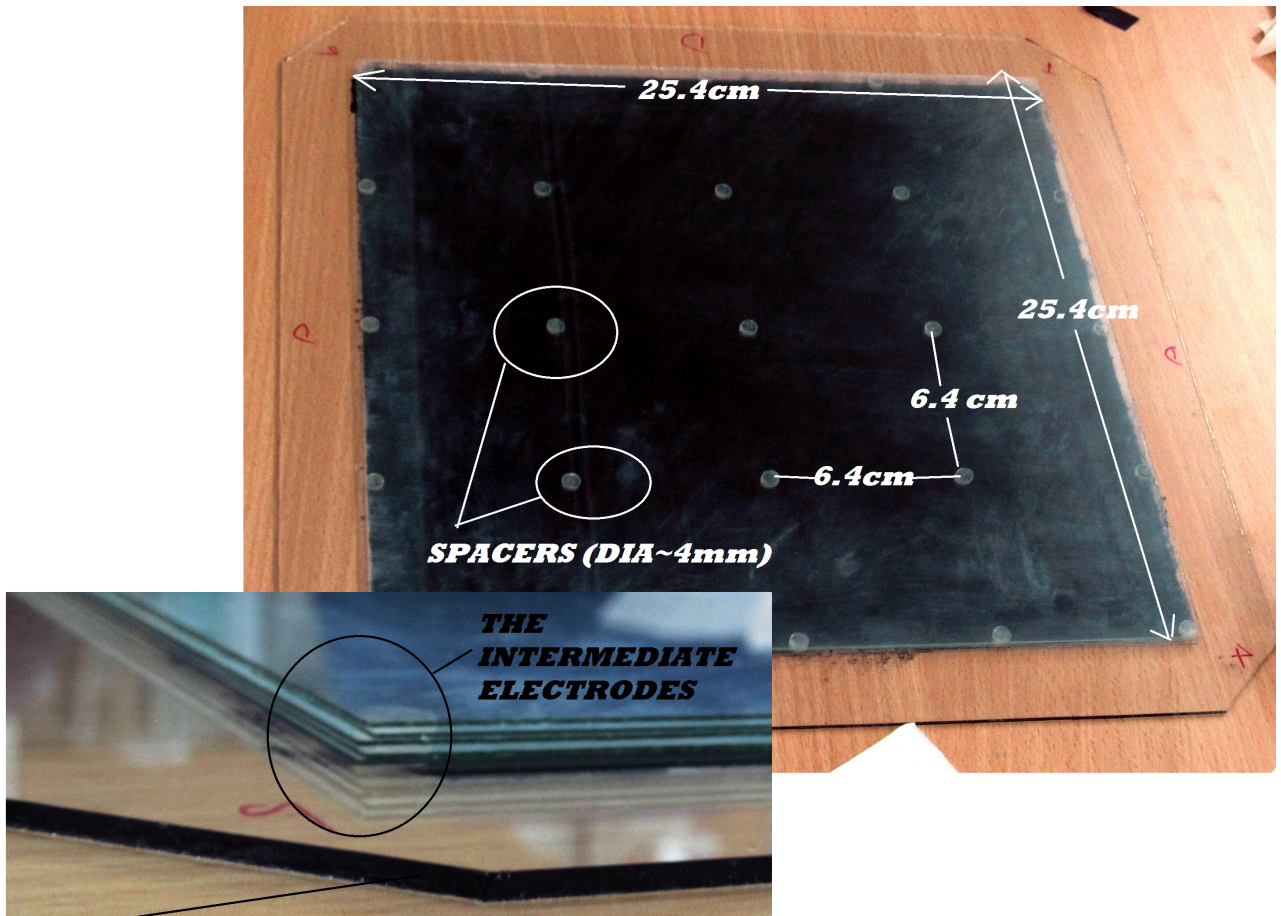
- Switching to bigger dimension.
  Outer electrodes 31 cm $\times$ 31 cm,
  Intermediate ones 27 cm $\times$ 27 cm.
- A sealed enclosure for gas flow.
- Problems: Alignment of the external trigger
  Ensuring a proper gas flow through the sub gaps.

The optimized design



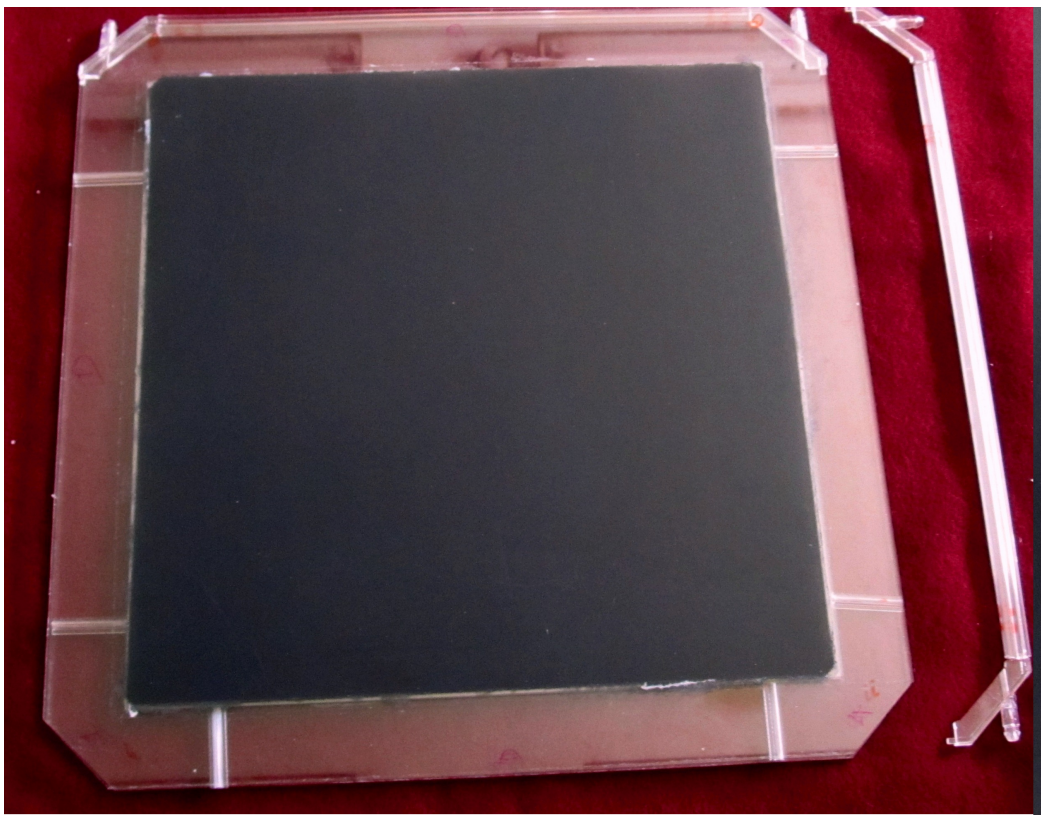
Development of MRPC (6-gap) at TIFR.

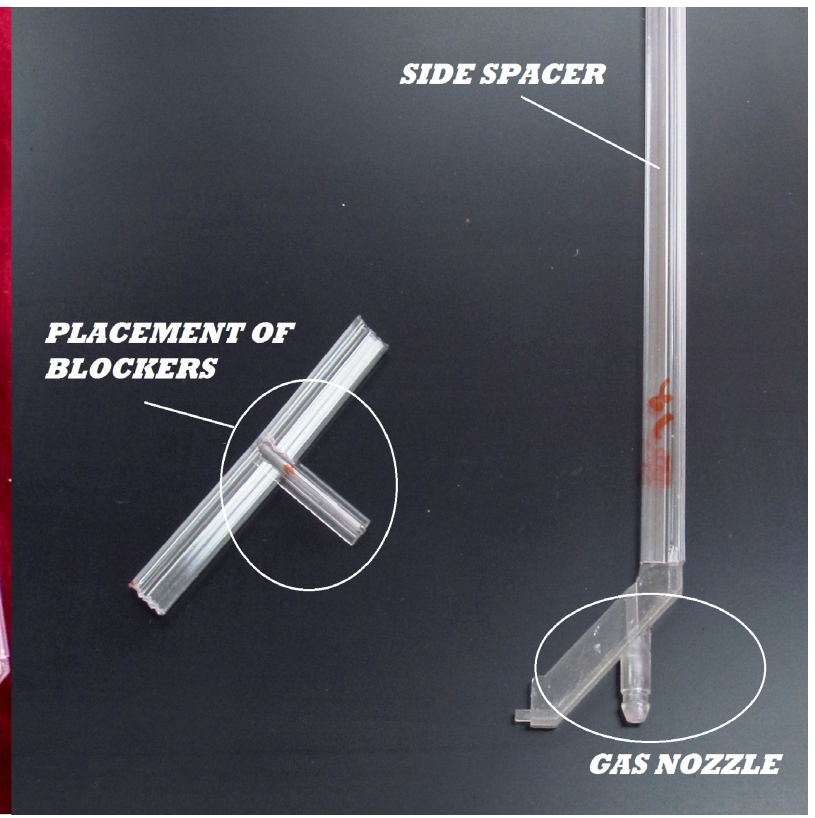
- Conductive graphite coat on external electrodes: surface resistances (0.5-1) MΩ/□
- Spacers: Diameter 4mm, Thickness 250 μm [2-sided non conducting adhesive tapes (100 μm) sticked on Mylar sheet (70 μm)]



Fabrication: Design of Spacers and blockers

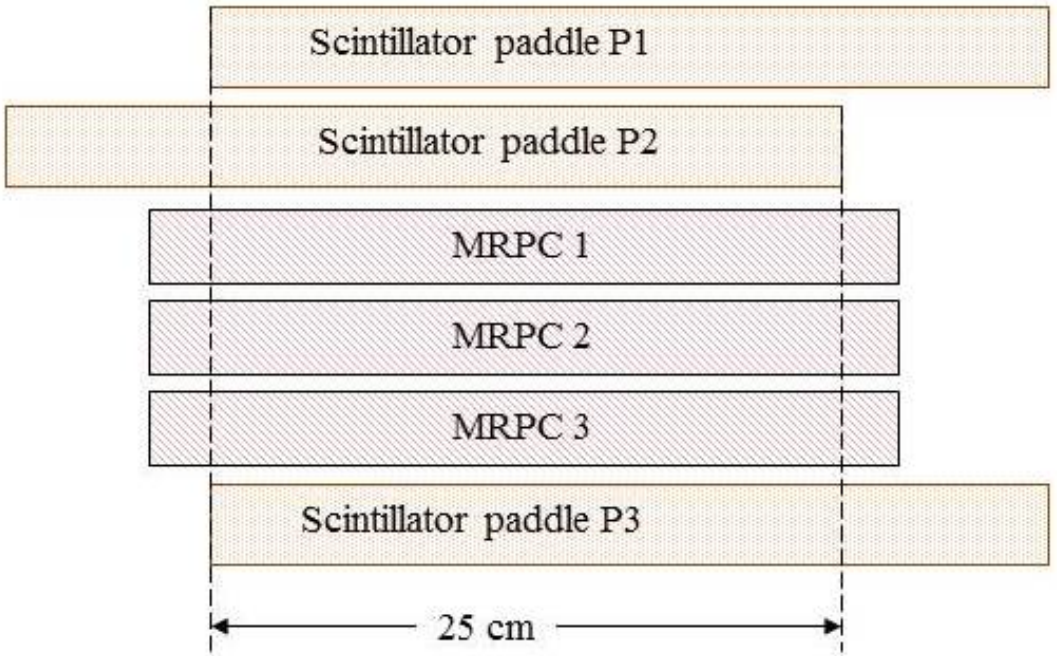
- The edges of the MRPCs are sealed using side spacers, and gas is flown through nozzles fitted at the four corners
- To ensure a proper gas flow through the sub-gaps, blockers are used



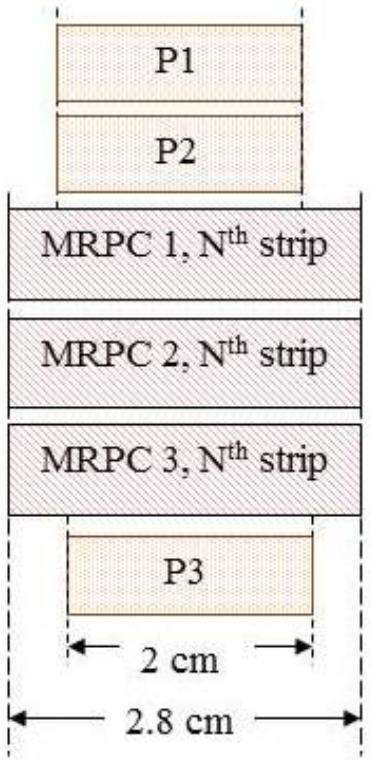


- **The experimental set-up**

The cosmic muon telescope

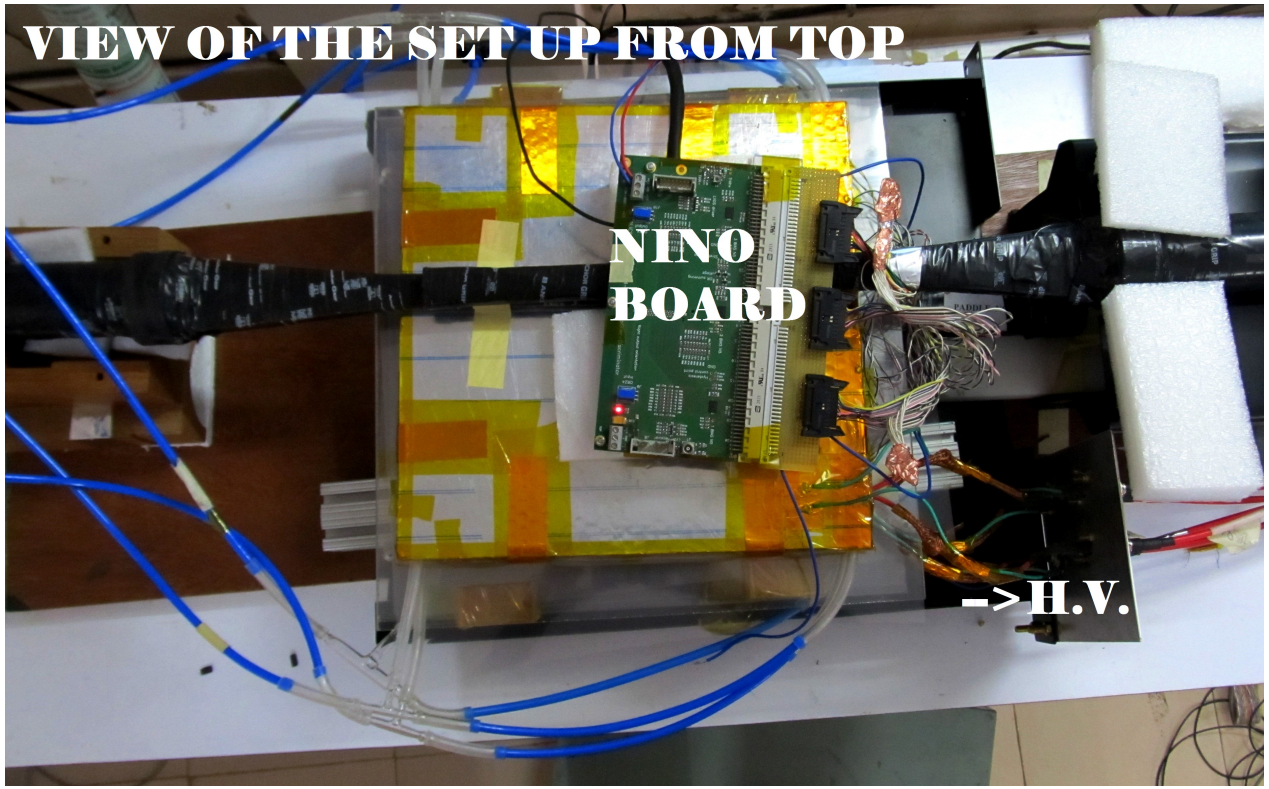


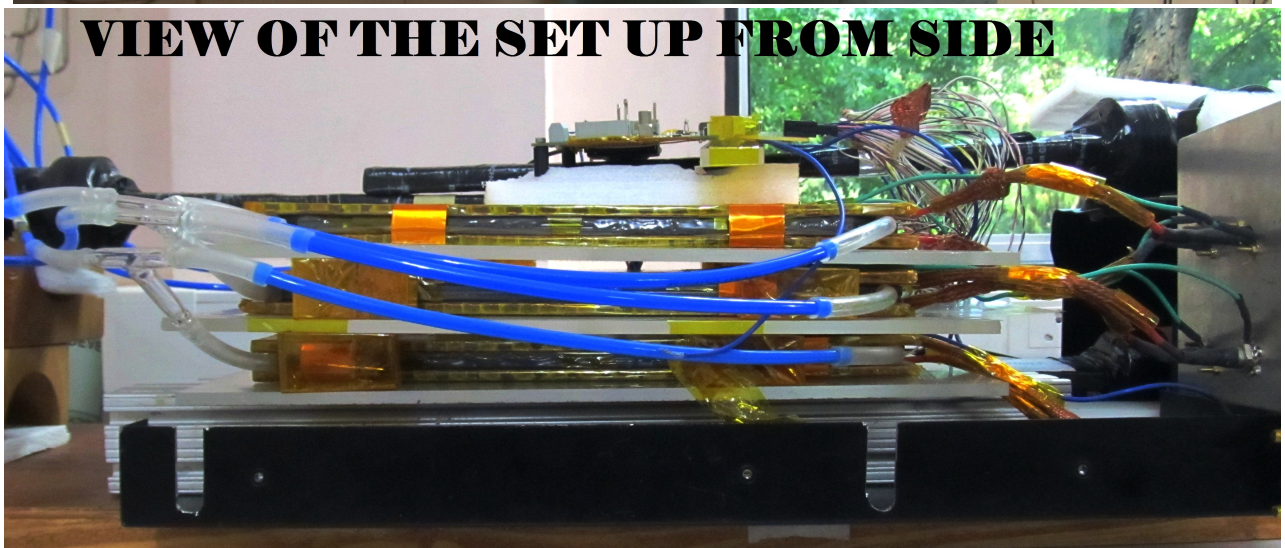
(a) View along the strip



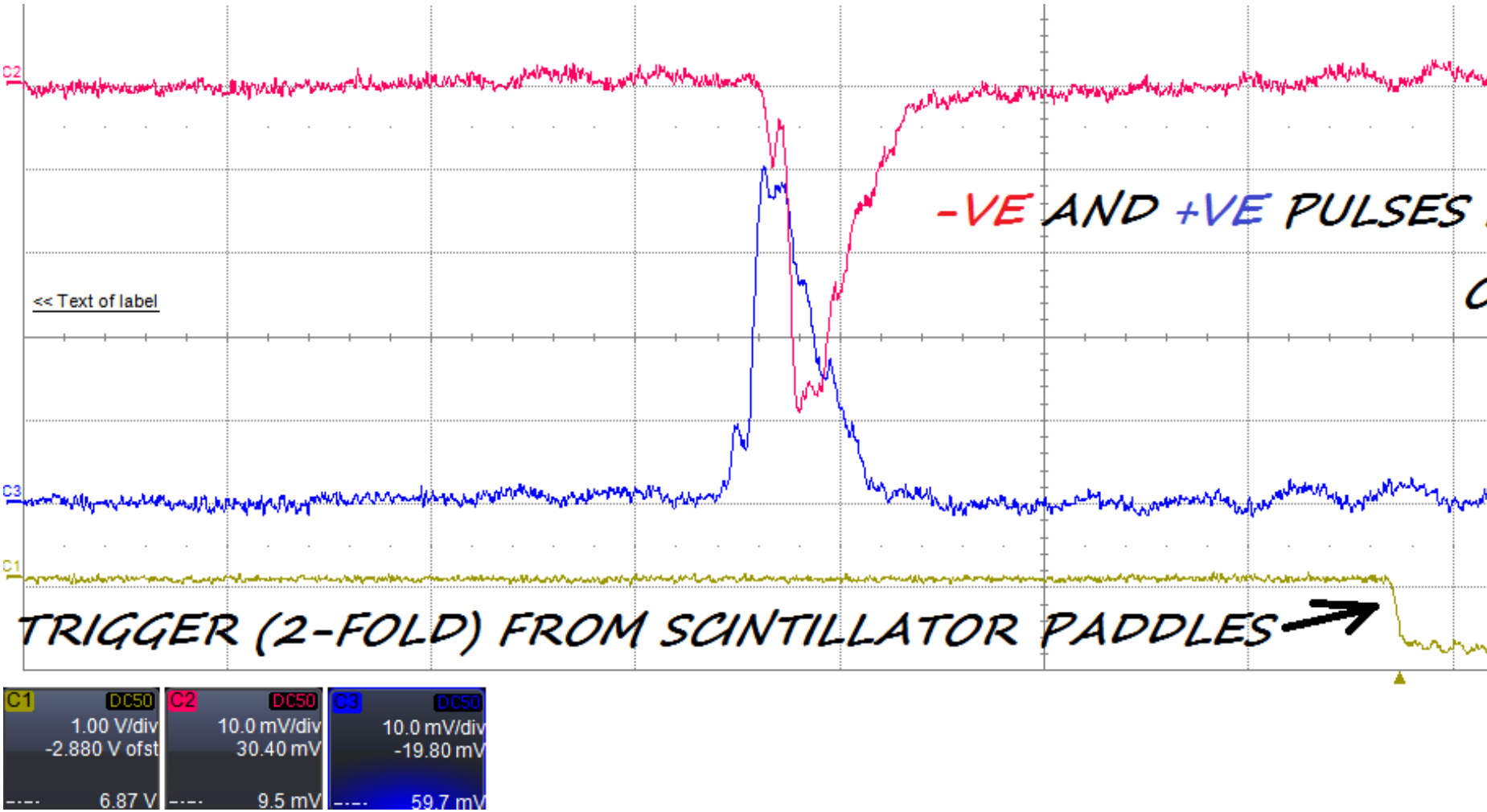
(b) View perpendicular to the strip

The Set up


VIEW OF THE SET UP FROM TOP
NINO
BOARD
->H.V.


VIEW OF THE SET UP FROM SIDE

Raw Pulse


C2
C3
C1
<< Text of label
-VE AND +VE PULSES
TRIGGER (2-FOLD) FROM SCINTILLATOR PADDLES
C1 DC50
1.00 V/div
-2.880 V ofst
6.87 V
C2 DC50
10.0 mV/div
30.40 mV
9.5 mV
C3 DC50
10.0 mV/div
-19.80 mV
59.7 mV

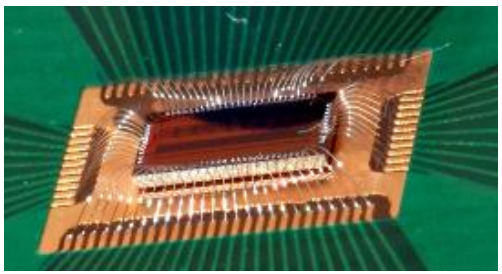
Outline

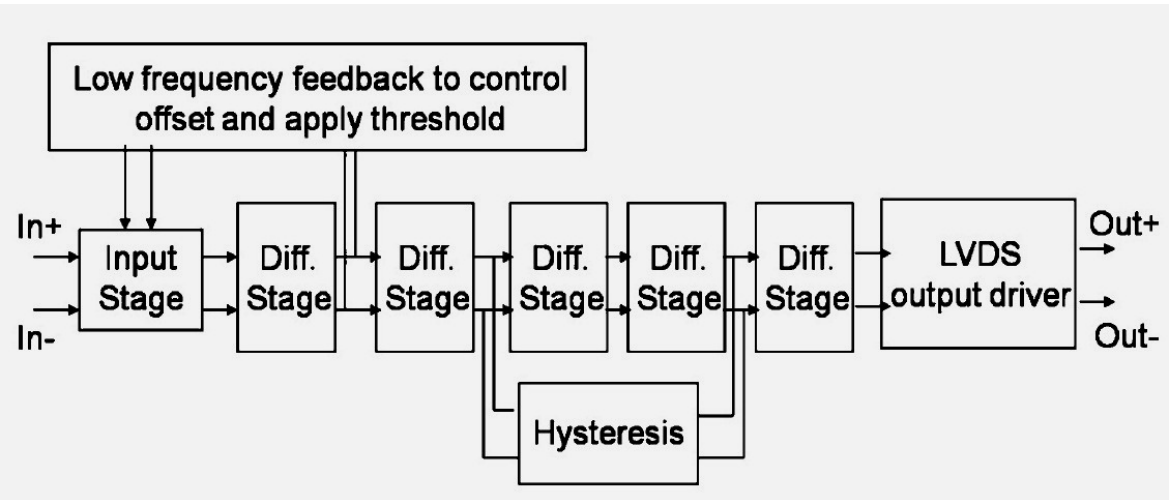
- **The data acquisition system**

NINO ASIC

- Its an ultra fast front end preamplifier-discriminator chip, initially designed for MRPCs in the ALICE TOF experiment

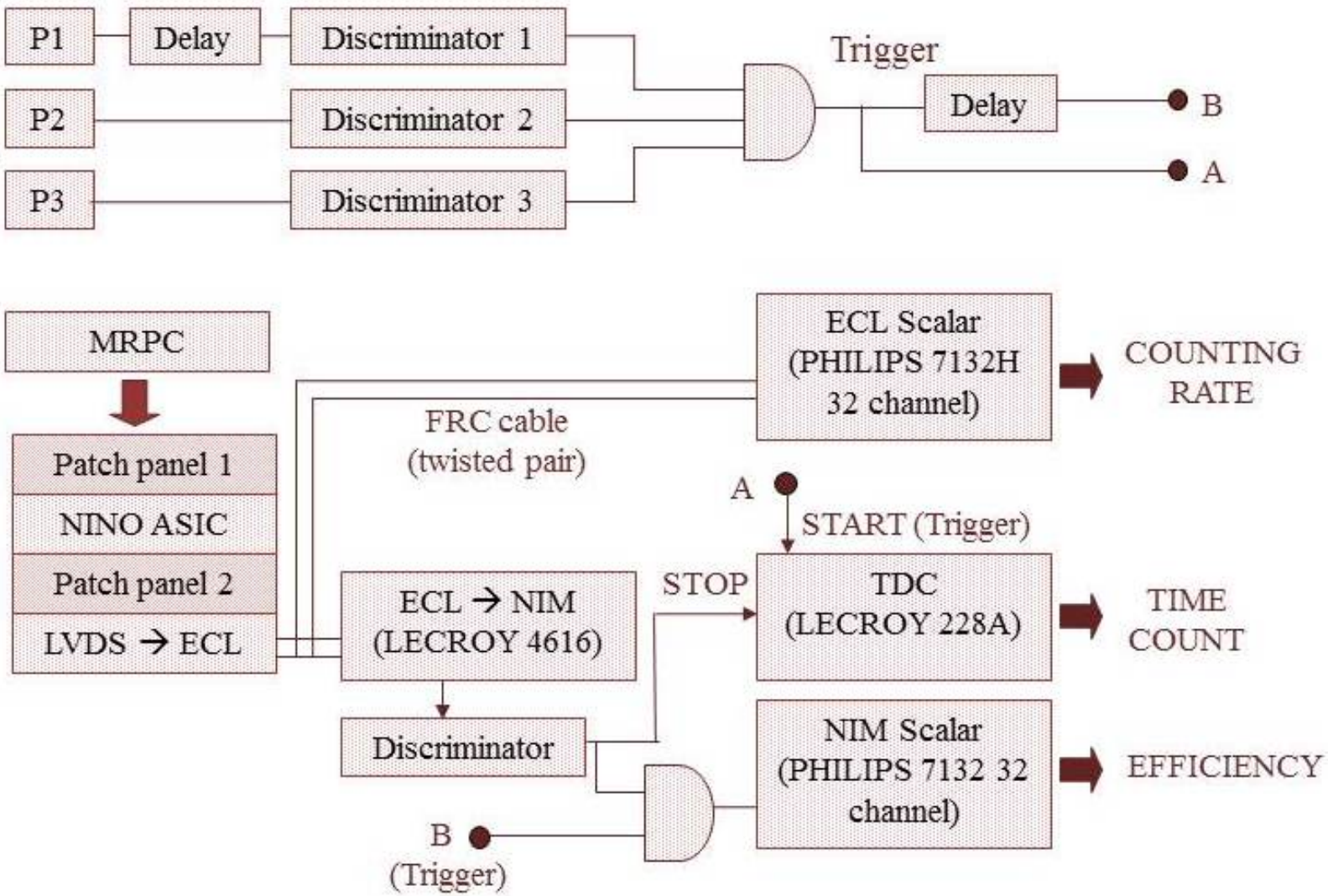
- Each chip has got 8 channels. Each channel is designed with an amplifier with $<$1ns peaking time, a discriminator with a minimum detection threshold of 10fC, and an output stage





Ref. Anghinolfi et al.,NIM A 533(2004) 183–187

DAQ Scheme

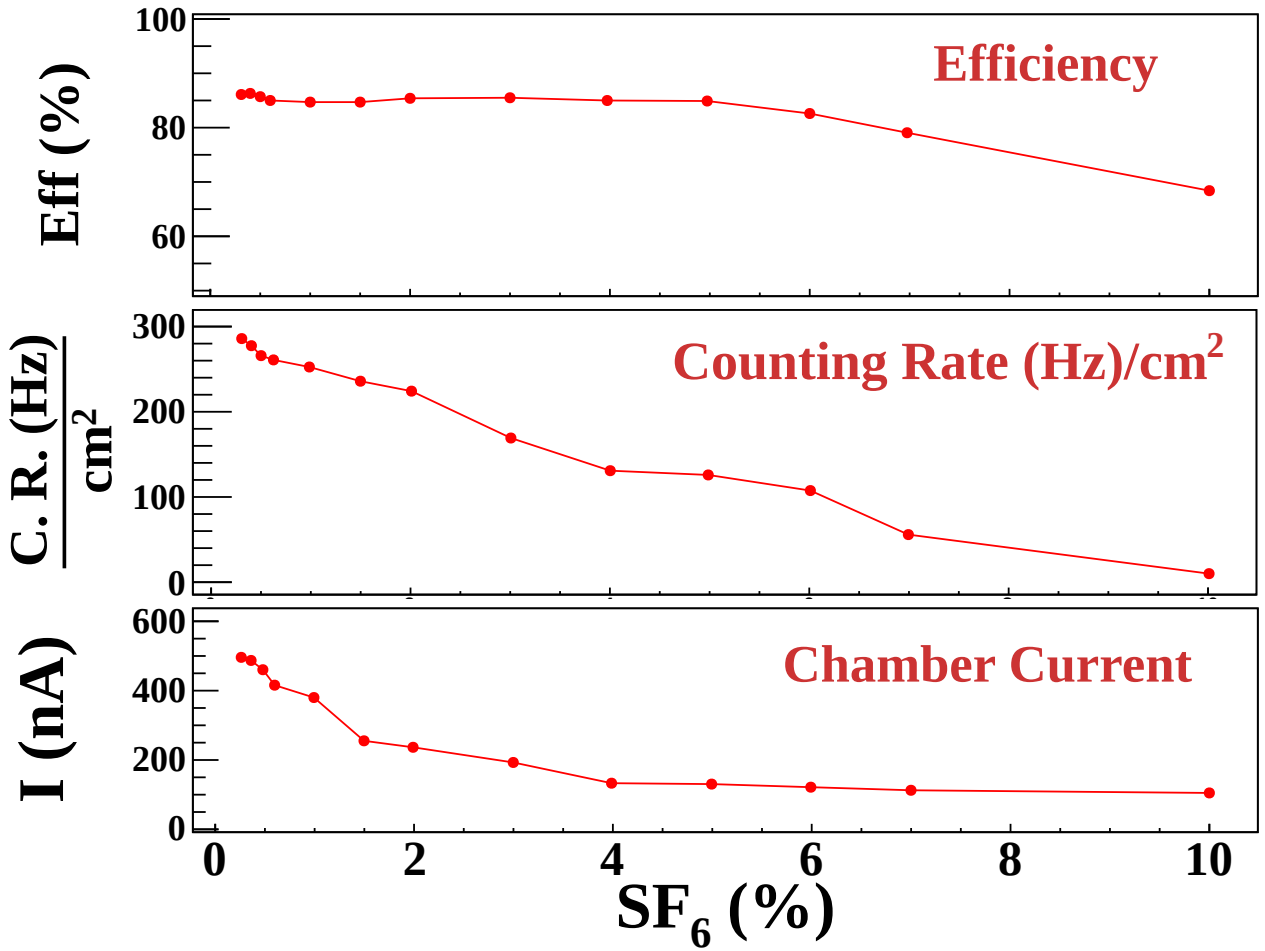

P1
Delay
Discriminator 1
P2
Discriminator 2
P3
Discriminator 3
Trigger
Delay
B
A
MRPC
Patch panel 1
NINO ASIC
Patch panel 2
LVDS → ECL
FRC cable
(twisted pair)
ECL Scalar
(PHILIPS 7132H
32 channel)
COUNTING
RATE
A
START (Trigger)
STOP
ECL → NIM
(LECROY 4616)
TDC
(LECROY 228A)
TIME
COUNT
Discriminator
NIM Scalar
(PHILIPS 7132 32
channel)
EFFICIENCY
B
(Trigger)

- **Characterization**

Characterization: Optimization of gas mixture

- A gas mixture with R134a(90%), C_4H_{10}(5%), SF_6(5%) was optimized for timing study with MRPCs in some experiments
- Higher SF_6 in the gas mixture quences the ionisation quickly, it helps us to operate the MRPC at higher voltages without a much shot up noise rate, and the time resolution improves
- Proportion of C_4H_{10} is kept at 4.94%.
- Proportions of SF_6 and R134a are varied

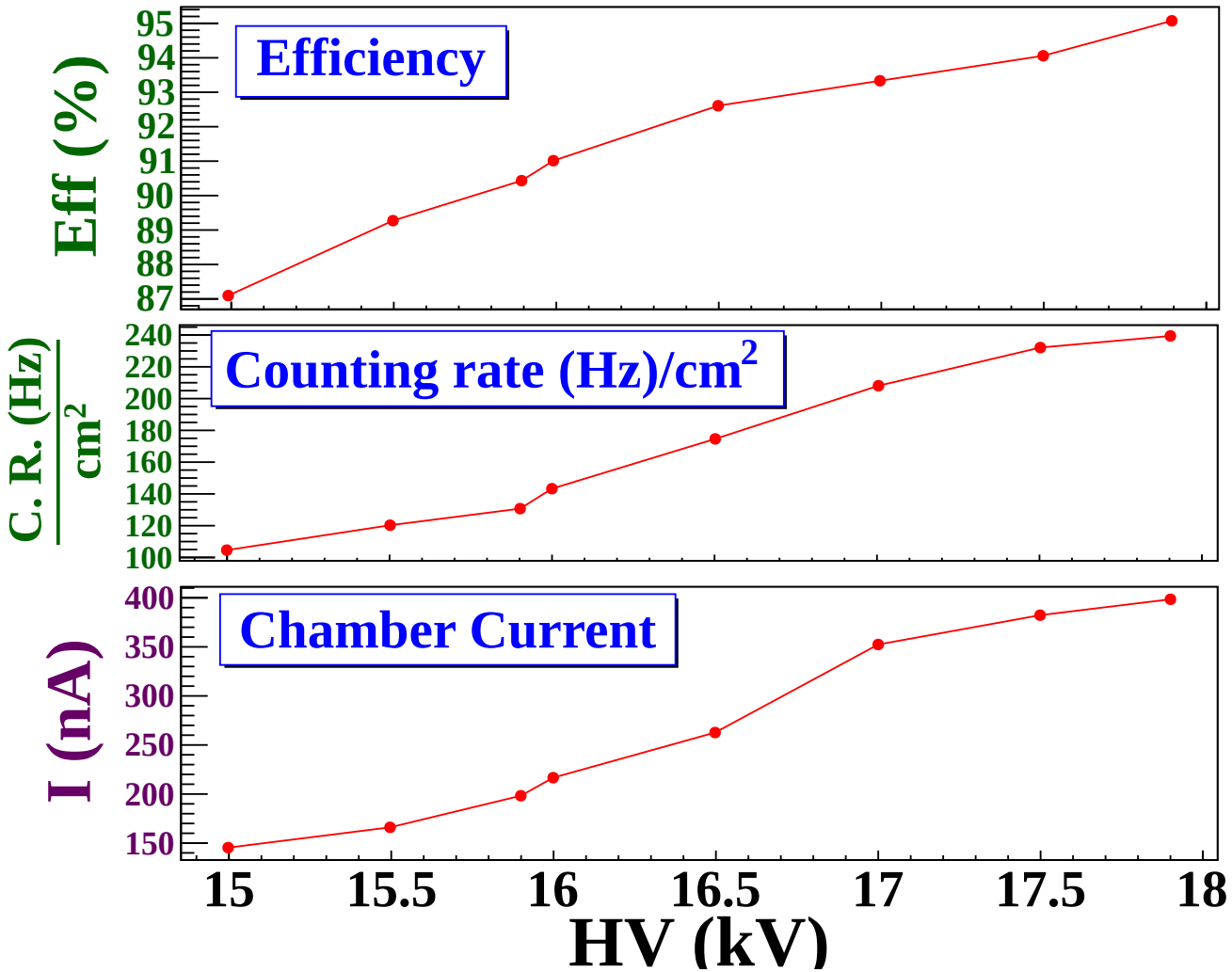
Study with SF6



4% SF_6 : Reasonable reduction in noise rate & chamber current, efficiency not deteriorated

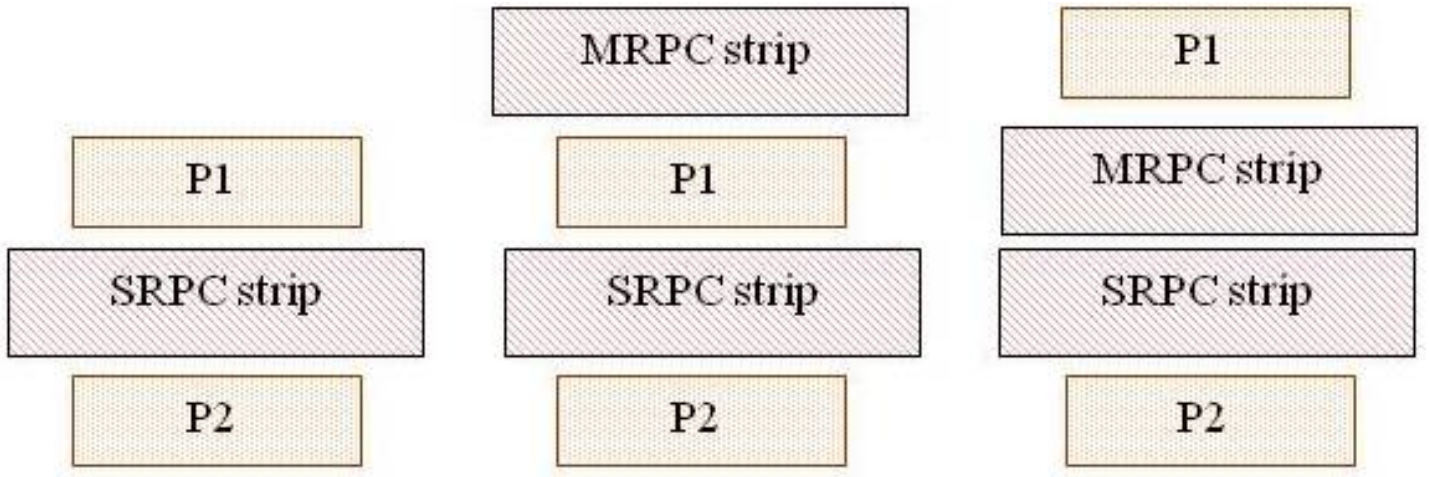
Characterization with Applied Voltage

Gas composition: R134a(91.06%), C_4H_{10}(4.94%), SF_6(4%)



HV: Reasonable noise rate and chamber current at 17.9 kV

MRPC as a part of trigger for single-gap RPC

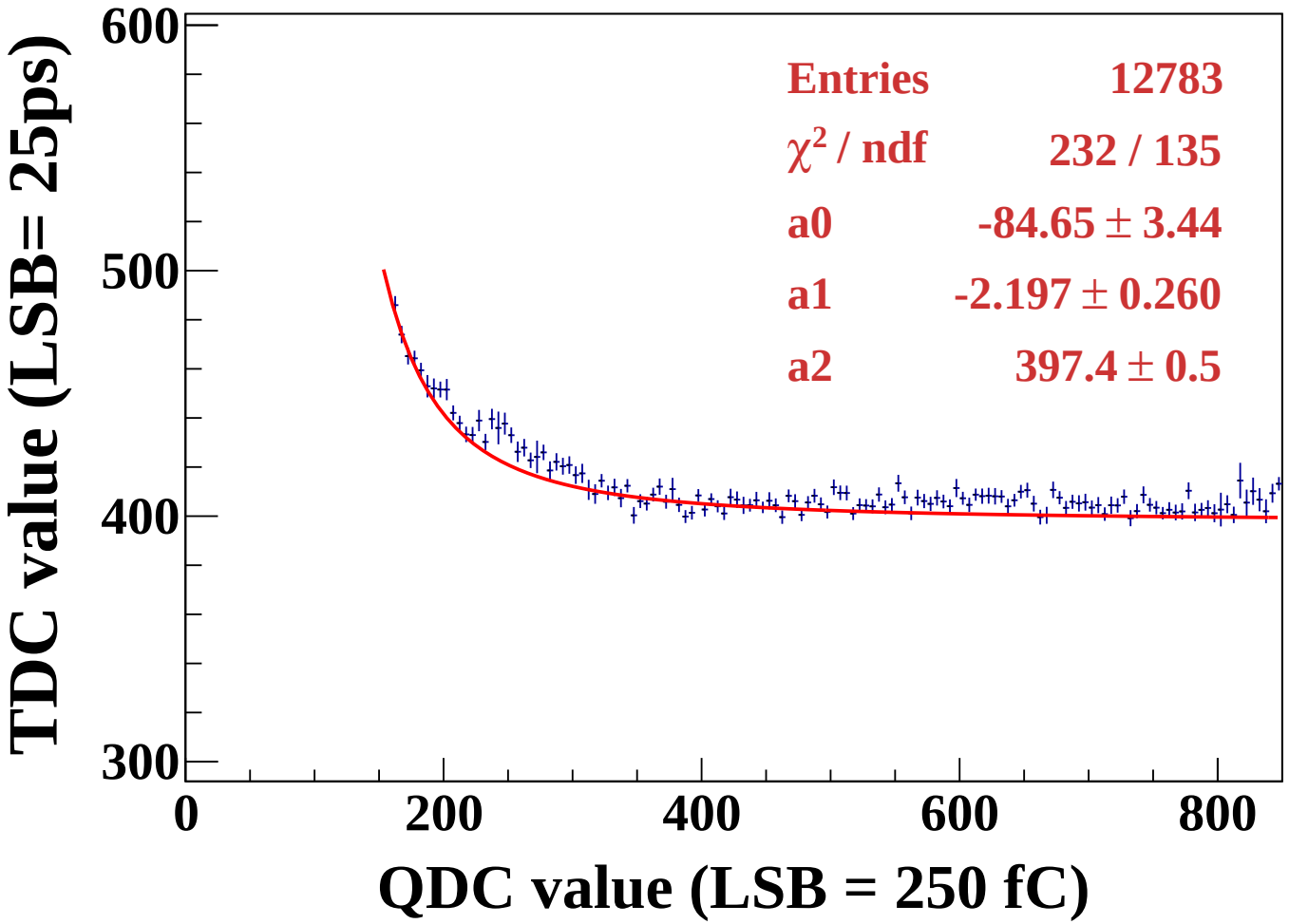


(a) Set up I (b) Set up II (c) Set up III

	Trigger	*Eff.*(%)	*Time res*(*ns*)	*Count*($\frac{Hz}{cm^2}$)	*I*(*nA*)
I	*P*1, *P*2	85	1.52	1.5	305
II	*P*1, *P*2, *MRPC*	86.9	0.9	2.85	312
III	*P*1, *P*2, *MRPC*	87.1	0.87	1.93	320

- **Timing study**

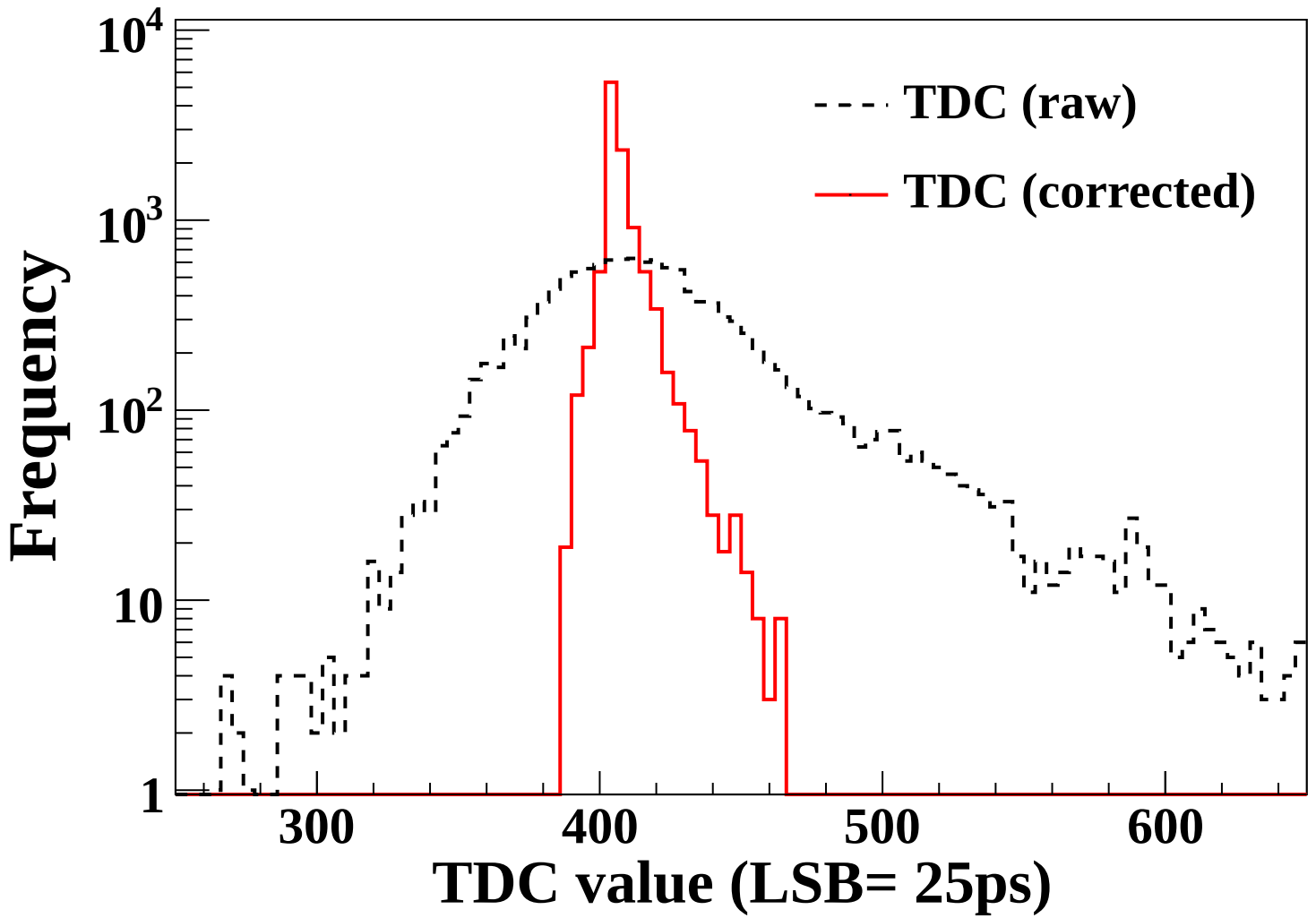
Time walk correction



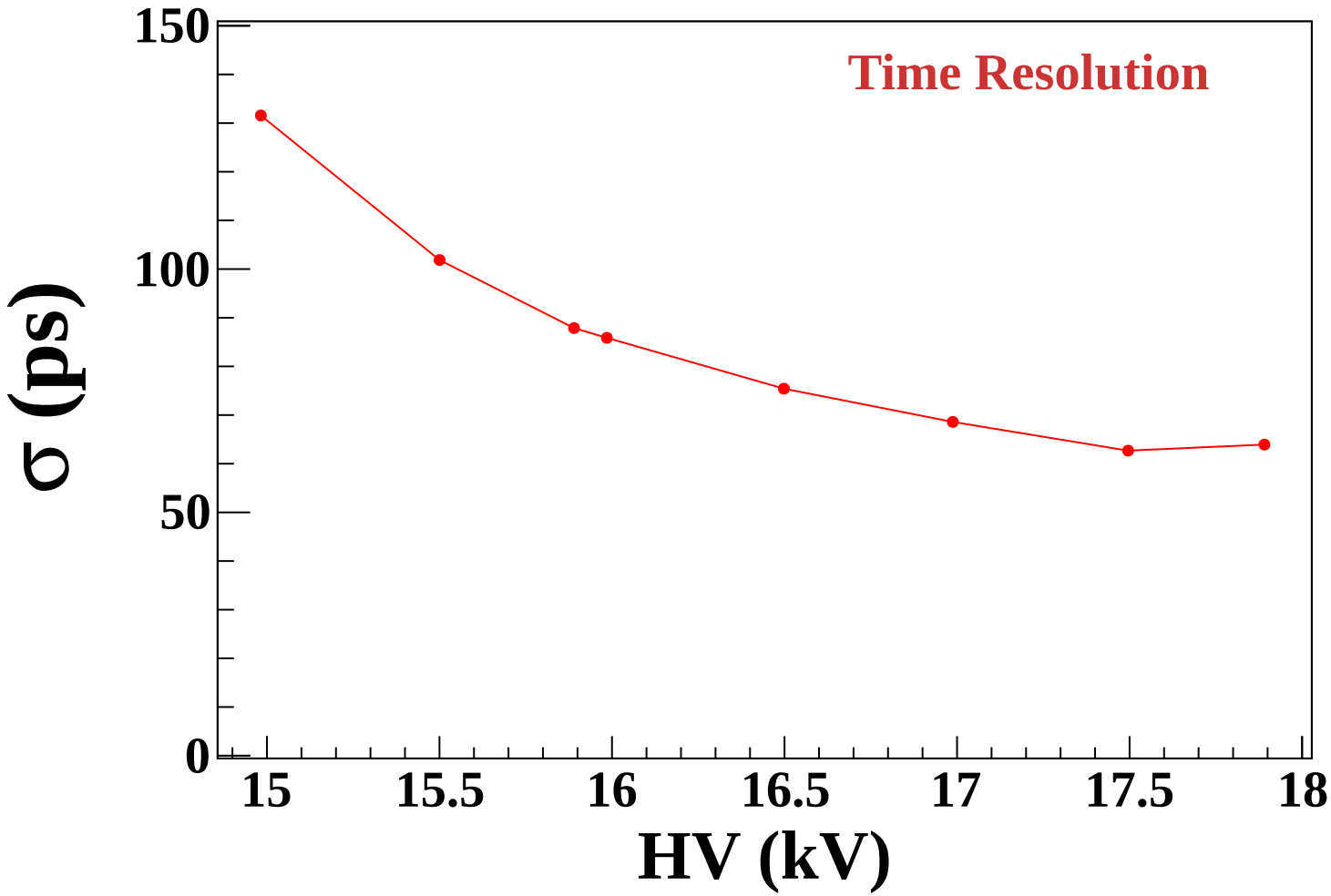
Fitted to $\exp(-a0/x + a1) + a2$

Anusparsh preamplifier used to obtain both analog and digital output for this work

Correcting the timing distributions for time walk

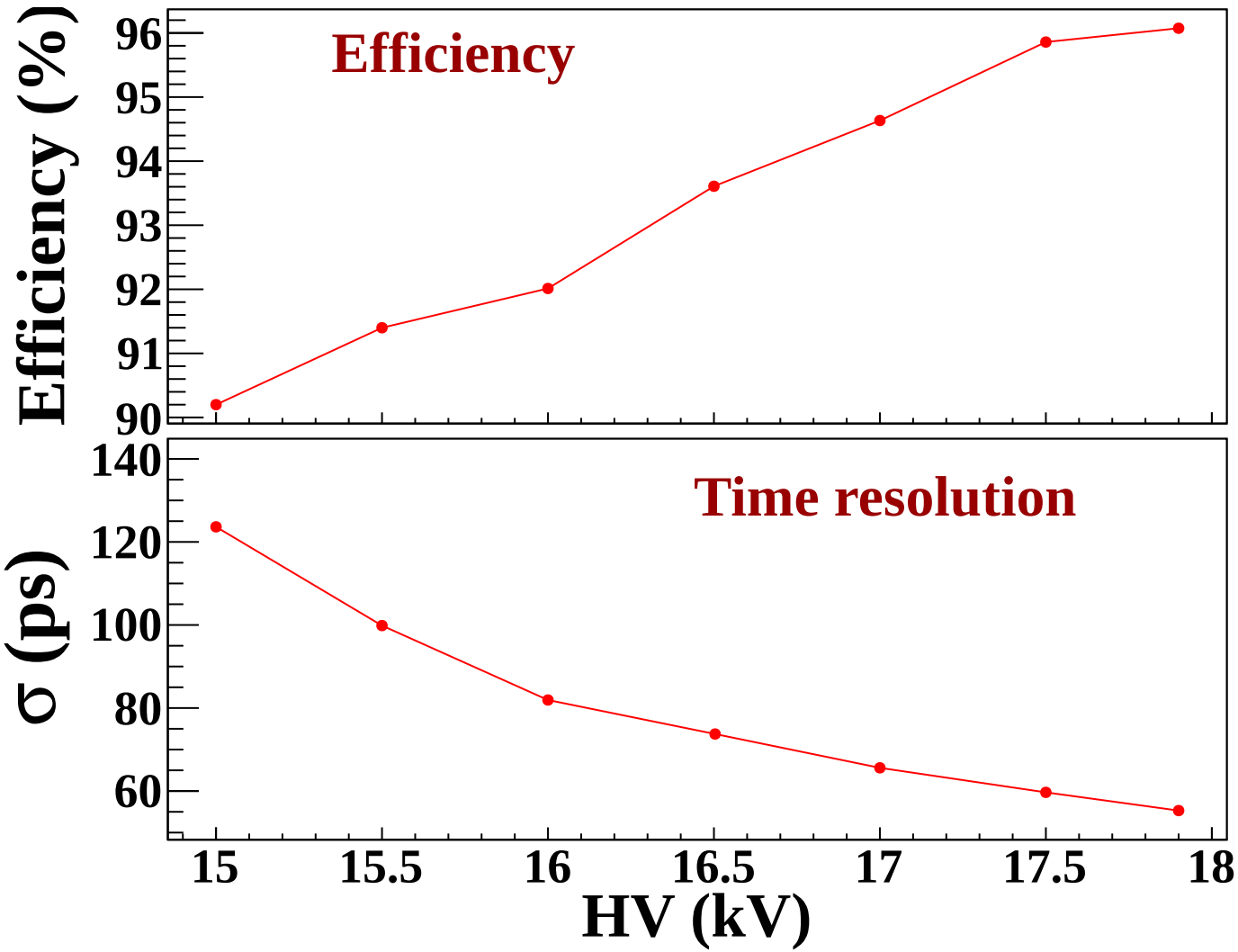


Time resolution



Also includes electronic jitter [15 – 25 ps]

With a Cs-137 source



Concluding Remarks

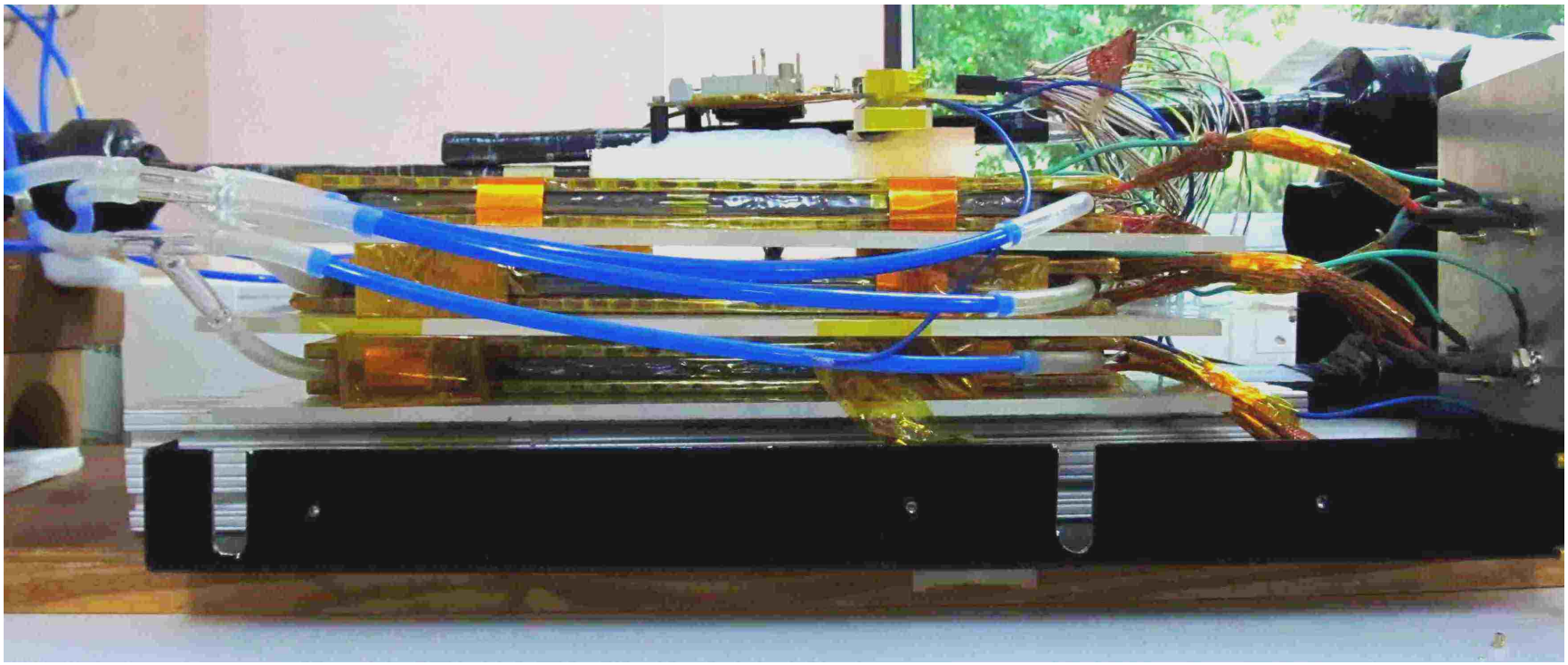
- 6-gap MRPC design has been optimized and the MRPCs are now in operation
- MRPC characteristics e.g. efficiency, noise rate and leakage current are studied at different operating voltages
- The gas mixture of R134a, C_4H_{10}, SF_6 has been optimized
- Time resolution $\sim$ 60 ps

Future Plans

- To test the detector stack for various applications. The use of it as a part of the external trigger for single gap RPCs show promising result.
- TOF study with MRPCs.
- Upgradation to double stack configuration.
- Fabrication of larger MRPCS (100 cm $\times$ 100 cm).

Acknowledgement

- Prof N.K. Mondal, Prof V.M. Datar, Prof G. Majumder, R.R. Shinde, P. Verma, S. R. Joshi, Mandar Saraf, Darshana Gonji, Santosh Chavan, Vishal Asgolkar



Thank You!